MULTI-PATIENT MONITORING SYSTEM USING A RELIABLE WIRELESS SENSOR PROTOCOL

KOH KIM HO

This thesis is submitted as partial fulfillment of the requirements for the award of the Bachelor of Electrical Engineering (Hons.) (Electronics)

Faculty of Electrical & Electronics Engineering
Universiti Malaysia Pahang

NOVEMBER, 2009

ABSTRACT

Patient monitoring system is a monitoring system for providing continuous health monitoring of a patient. The aim is to collect and store important parameters of patient during critical period. In addition, it also helps to improve patient care and make early detection of medical emergencies. Previous monitoring systems are using wired system which can be seen right next to the patient. Now with wireless, nurses can monitor patients in distance. Next, too much of wire will easily cause accident. In addition, patient movements will also be limited. Therefore, wireless eliminates unsightly cables and patients can freely move around. Besides, wired system will cause the transmission delay problem. But, with wireless technology, the delay problem will be reduced.

ABSTRAK

Sistem pemantau pesakit merupakan satu sistem yang dapat menantau kesihatan pasakit secara berterusan. Tujuannya adalah untuk mengutip dan menyimpan parameter yang penting dari pesakit pada tempoh genting. Selain itu, sistem ini membantu untuk meningkatkan kebajikan pesakit dan membuat pengesanan awal terhadap kecemasan perubatan. Sistem pemantau terdahulu menggunakan sistem pendawaian yang hanya dapat dipantau bersebelahan dengan pesakit sahaja. Dengan mempunyai teknologi *wireless*, jururawat dapat memantau pesakit pada jarak jauh. Seterusnya, kemalangan senang berlaku jika terdapat kabel yang banyak. Tambahan lagi, pergerakan pesakit juga terhad. Oleh sebab itu, *wireless* mengingkirkan dawai supaya pesakit boleh bergerak sesuka hati. Selain itu, sistem kabel mengakibatkan masalah penangguhan penghantaran data. Akan tetapi, teknologi *wireless* dapat menguragkan masalah ini.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF SYMBOLS

GUI	Graphical User Interface
PC	Personal Computer
V	Volt
DC	Direct Current
MHz	Mega Hertz
EIA	Electronics Industries Association
ADC	Analog to Digital Converter
TE	Transmission Enable
VT	Valid Transmission
USB	Universal Serial Bus
cc	Clock Cycle
°C	Degree Celsius
RF	Radio Frequency
GND	Ground
Vcc	5V DC
EEPROM	Electrically Erasable Programmable Read-Only Memory
FM	Frequency Modulation
LED	Light Emitting Diode
bps	Bit per Seconds
ASCII	American Standard Code for Information Interchange
GSM	Global System for Mobile communication
GPS	Global Positioning System

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

Multi Patient Monitoring System is a wireless based biomedical monitoring system. Wireless technology is now widely used in communication area to facilitate information transfer and exchange. This wireless technology is applied in Multi Patient Monitoring System in order to eliminate the use of cables, which provide enormous for patients. Multi Patient Monitoring System can be applied in a variety of health care scenarios such as paramedic, diagnostic, surgical, and post-operative phases.

In order to that, a sensor is required to acquire medical parameter from patient. Recently, biomedical sensors are introduced in digital world. Digital sensor has advantages over analog sensor such as greater accuracy and resolution. In addition, the digital sensor requires minimum reading time compared to its compatriot. Moreover, digital signal has greater noise immunity. In fact, the chance for data loss and data error will be greatly reduced. Nowadays, biomedical sensors are increasingly used in monitor biological parameters for patient and detect abnormal biological changes.

But the system needs a brain for signal processing. Hence, a reliable microcontroller is implemented in this project. Embedded controller technology has continuously improved in functionality, performance and power consumption. Microcontroller is now integrated with some extra component to increase the functionality and execute at high frequency to improve the system performance. The power consumption are greatly reduced in order to increase the time of operation when operate with battery.

Besides, sophisticated software for user interface is important. Graphical User Interface (GUI) is a type of user interface application that allows people easily to interact without typing complex command. GUI provides graphical icons and visual indicators for the users easier to learn and use. In addition, GUI has the capability of multitasking which can perform several tasks simultaneously. This advantage, undoubtedly increase the efficiency of the monitoring system tremendously.

1.2 Project Objective and Scope

The objective of this project is to develop a Multi-Patient Monitoring System. This system capable of monitoring several parameters of each patient and send these data to central unit so that these parameters can be displayed and stored on the main station. These parameters are continuous monitored and updated in defined function or interval set by the system.

In order to provide a simple, high performance and stand alone system, wireless technology is explored in the design and allows patients to move freely without any cable attach to his body. This obviously offers versatility and flexibility to the system.

In order to achieve the project objective, the scope of project are summarise as follow:

- Microcontroller system to control the operation of control centre and patient remotes
- Radio frequency transceiver system to transmit and receive data using radio wave
- Sensory module to acquire medical parameter from patient
- GUI to display and update the status of patient continuously

1.3 Thesis outline

The thesis is orderly organized into 6 chapters and they are outlined as below:

Chapter 1 introduces various technologies that invent recently. It also outlines objective and scope of this project.

Chapter 2 describes the architecture and basic operation of the project. It gives a brief review of microcontroller system board architecture, wireless communication module, sensor module and serial communication module.

Chapter 3 provides description and discussion on the design of the hardware of each module in the systems. The module consists of microcontroller board, sensor, encoder and decoder, transceiver and serial communication.

Chapter 4 indicates the development of the software of each module and system operation as well as GUI development. This chapter also includes the flowchart of each module.

Chapter 5 presents various testing and results that are conducted to each module. This chapter also includes the complete circuit diagram and programming.

Lastly, Chapter 6 summarise the overall conclusion for this thesis and a few suggestion and recommendation for future development.

CHAPTER 2

SYSTEM ARCHITECTURE AND OPERATION

2.1 Introduction

A basic block diagram of Multi-Patient Monitoring system is shown in Figure 2.1 where temperature of both patients is monitored at control centre. Medical temperature sensor is implemented in both patient modules. The sensors read current body temperature of each patient and display on PC using GUI. The temperature reading will be updated every minute and logged into database.

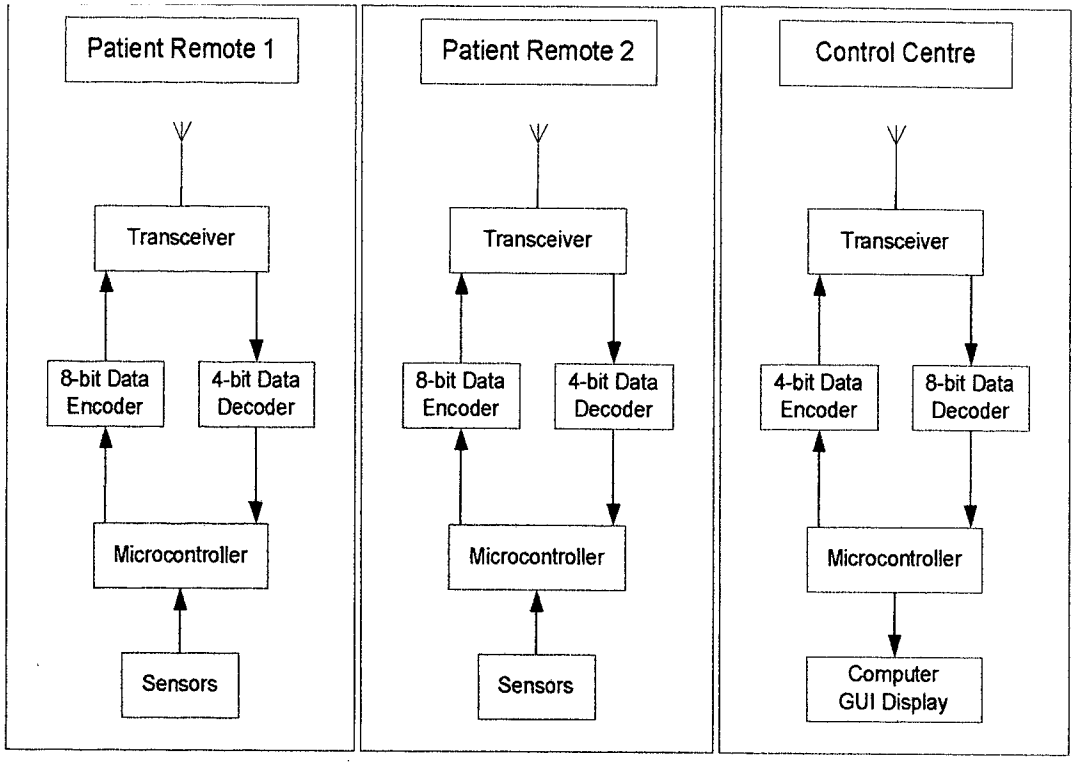

Figure 2.1: Block Diagram of Remote Multi-Patient Monitoring System

2.2 Microcontroller System Board Module

Microcontroller is the brain of the system. Microcontroller MC68HC11A1 is chosen to implement in this project due to its high performance, high speed, low power consumption, various function and features. Furthermore, MC68HC11A1 is operating in bootstrap mode because it does not require extra input and output ports. Bootstrap mode allows the programs to be loaded into internal EEPROM. The block diagram of system board as shown in Figure 2.2 consists of power circuit, reset circuit, clock circuit and EIA232 module. Power circuit is needed to provide constant and stable 5V DC voltage to the system while reset circuit is used to initialize the microcontroller process into its normal operation. Clock circuit is required to supply constant 2 MHz clock speed. EIA232 module is important to communicate serially between microcontroller and computer.

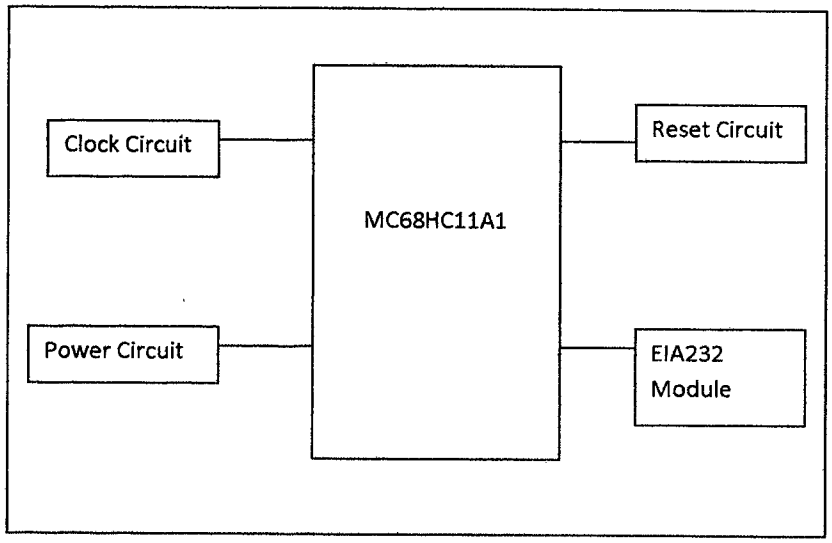

Figure 2.2: Block Diagram of Microcontroller Board Module

2.3 Sensor Module

TSic 301 as indicated in Figure 2.3 is used in this project to read the body temperature of patient. It is an integrated circuit sensor that can be used to measure temperature with an electrical output which is proportional to the temperature in degree Celsius. The output of this sensor is measured in analog voltage. The output of TSic 301 is then amplified by scale of 5 and connected to the internal ADC of microcontroller.

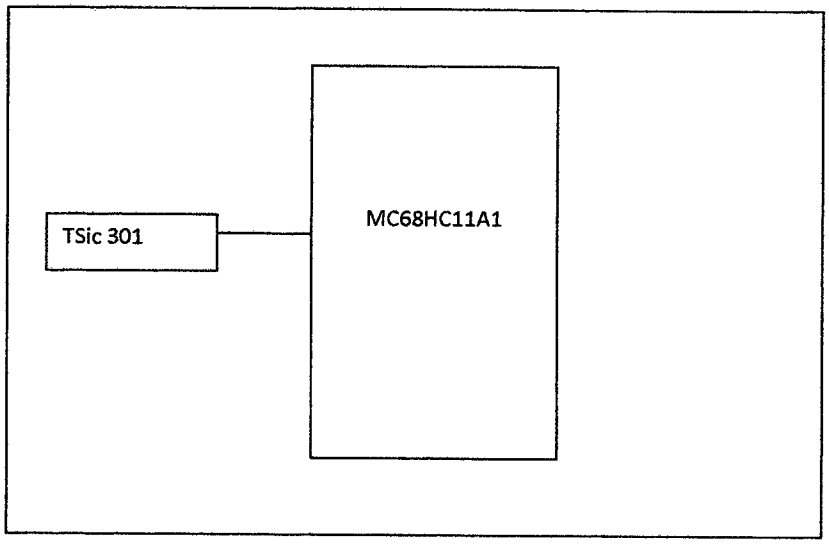

Figure 2.3: Block Diagram of Sensor Module

2.4 Wireless Communication Module

A basic block diagram of wireless communication module is shown in Figure 2.4. The transceivers that operate at 433 MHz is chosen as the medium of transferring data. Transceiver transfer data using Amplitude Shift Keying (ASK) modulation technique.

Data encoder read parallel data from microcontroller and manipulates it into serial format before transmits using transceiver. At the other side, the data decoder will receive the signal from transceiver. Data decoder then decodes the serial data and regenerates the original data in the parallel form.

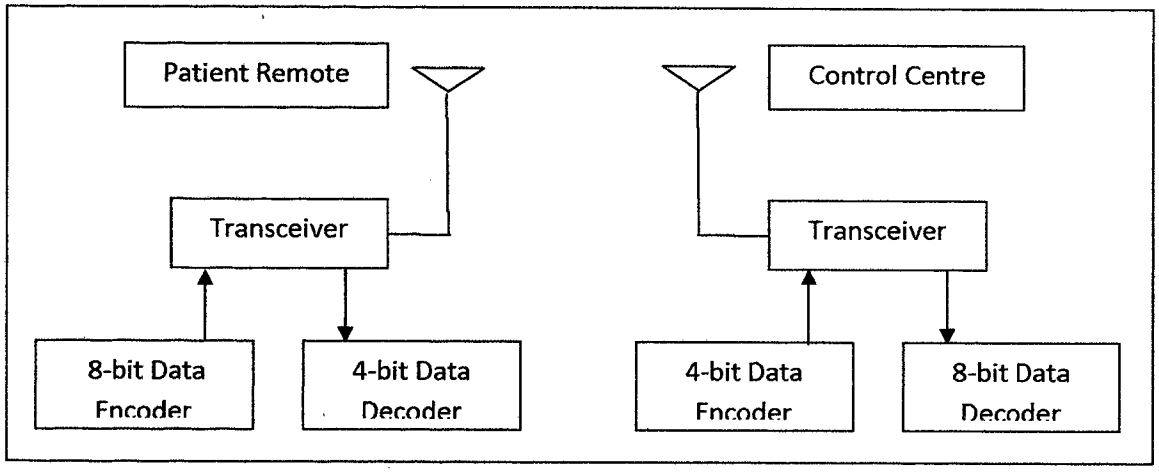

Figure 2.4: Block Diagram of Wireless Communication Module

2.4.1 Encoder and Decoder Module

Data encoder is used to change a parallel data into serial data. The data may serve any of a number of purposes such as compressing information for transmission or storage, encrypting or adding redundancies to the input code, or translating from one code to another. Data encoder that implemented in this project is HT640 and HT12E. HT640 is capable to encode 18 bits of information which consists of 10 address bits and 8 data bits. While HT12E is capable to encode 12 bits of information which consists of 8 address bits and 4 data bits. The application flexibility of this encoder is enhanced by the capability to select a TE trigger type.

Data decoder is a device which does the reverse of encoder. It is undoing the encoding to reproduce information. HT648 and HT12D are chosen as the data decoder in this project. HT648 is paired with the HT640 encoder. This decoder is capable of decoding 18 bits of information that consists of 10 bits of address and 8 bits of data. HT12E is paired with the HT12E encoder. This decoder is capable of decoding 12 bits of information that consists of 8 bits of address and 4 bits of data. Decoder receives serial data from that series of encoder and compares the serial input data twice continuously with its local address. The input data codes are decoded and transferred to output pins if no errors codes are encountered. At the same time, valid transmission (VT) is trigger high.

2.4.2 Transceiver Module

Transceiver is an electronic device which has the function of transmit and receive data. Transceiver propagates an electromagnetic signal with the aid of an antenna. Transceiver modulates the incoming signal information onto carrier frequency before it is transmitted. On other hand, transceiver demodulates the incoming signal information together with carrier frequency at receiver end. Transceiver used in this project is known as RTX MID 5V. It is able to transmit analogue or digital data over 200 metres. It is chosen because of its small size and the capability to transmit in high data rates. This type of transceiver is operated in frequency of 433MHz.

2.5 Serial Communication Module

There are several ways to communicate with PC such as using parallel port, serial port or Universal Serial Bus (USB). For this system, serial port is chosen to communicate with computer. In order to communicate via serial port, EIA232 module is required. EIA232 module is a standard protocol for transferring data via serial communication.

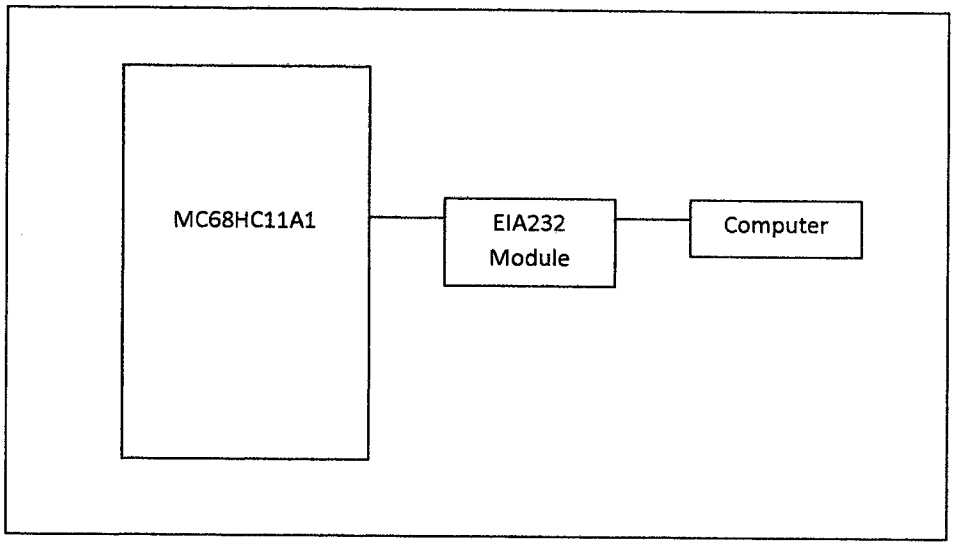

Figure 2.5: Block Diagram of Serial Communication Module

CHAPTER 3

HARDWARE DESIGN

3.1 Introduction

The hardware design consists of microcontroller board module, wireless communication module, encoder and decoder module, sensor module, and serial communication. The system board is designed to operate in Bootstrap Mode due to size and cost.

3.2 Microcontroller System Board Module

The microcontroller MC68HC11A1 is operating in Bootstrap mode. Hence, both MODA and MODB pins are grounded as shown in Figure 3.1. Microcontroller Board Module consists of power circuit, reset circuit, clock circuit, and EIA232 module. They are very important to support the basic operation of microcontroller.

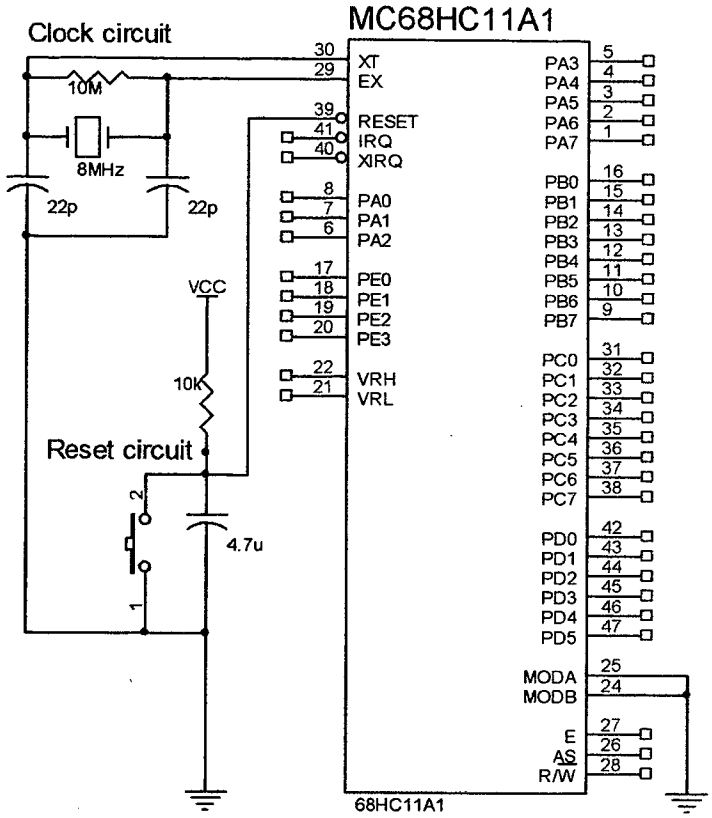

Figure 3.1: Microcontroller System Board Circuit